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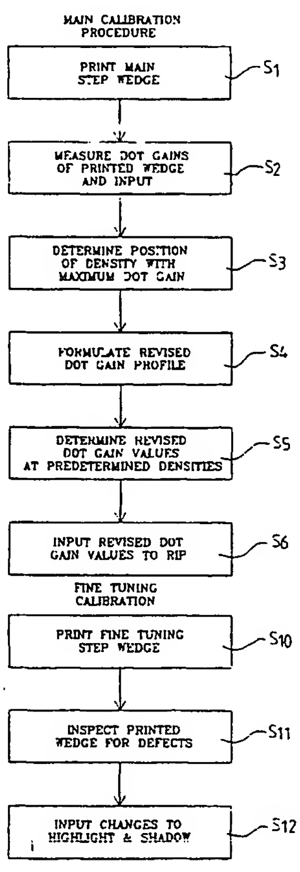
(54) Title: CALIBRATING PRINTING MACHINES



(57) Abstract: A method of calibrating a computer-controlled printing machine to produce printed copies of an original image to a pre-determined standard, comprises: using the printing machine to print a reproduction of a step wedge, having patches with densities concentrated in a central region of the density range, with the machine set to dot gain values corresponding to pre-determined density values on a standard dot gain profile; formulating a revised dot gain profile having the same shape as the standard dot gain profile but with a maximum dot gain which is equal to the maximum measured dot gain and which is located at the density having the maximum measured dot gain; determining revised dot gain values for the predetermined density values from the revised dot gain profile; and setting the dot gain values in the printing machine in accordance with the revised dot gain values.

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For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

"Calibrating Printing Machines"

This invention relates to improvements in or relating to the calibration of printing machines.

The faithfulness with which a printed image produced by a printing machine reproduces an original image to a pre-determined standard is termed the transfer function of the machine.

Modern computer controlled printing machines print images from printing plates on which a reproduction of an original image to be printed is formed from pixels each of which is composed of an array of dots. The proportion of the area of a pixel covered by dots determines the so-called density of the pixel and varies from 0% to 100%. When the printing plate is inked and applied by the machine to a substrate, such as paper, to form a printed image on the paper, the printed dots exhibit a phenomenon called dot gain which affects the transfer function of the machine. This dot gain effect is caused by spreading of the perimeter or shore line of the ink which forms the dots on the paper and causes an increase in the ink-bearing area of the printed pixel, with the result that the printed pixel has a greater density than that represented by the area of the dots on the corresponding pixel of the printing plate. As is well known, colour images are printed in several steps using different coloured inks to print each component or colour separations. For any given ink, the degree of dot gain, that is the percentage increase in the density of the printed dot over that indicated by the pixel on the printing plate, differs depending upon the indicted density of the pixel being printed, increasing with increasing density from zero to a maximum value at a density in the region of about 50% and decreasing again to zero at a density of 100%.

Printing machines are also able to produce printing plates with different numbers of lines of dots per unit of length transverse to the lines, the number of lines per unit of length being known as the screen ruling. It has been found in tests that dot gain increases as the screen ruling is increased and that, moreover, the maximum value of dot gain occurs at a different value of density.

In order to print a reproduction of an original image, the printing machine scans the original image to measure the density of the pixels of a notional pixel array into which the original image is divided for the purposes of reproduction. The dot gain effect has, however, to be taken into account when printing a reproduction from the scanned density values. This is achieved by correcting the scanned values in accordance with a set or profile of dot gain values set on the machine in accordance with information supplied by the manufacturer, a standard dot gain profile being used for any particular model of machine supplied by a manufacturer on the assumption that all machines of that model exhibit the same transfer function.

In practice, individual printing machines of the same model have different transfer functions even when new, that is to say the printed result achieved with the standard set of dot gain values differs from machine to machine and this variance becomes more pronounced as a machine ages.

Conventionally, in order to produce a faithful or optimised reproduction of an original image, a calibration procedure is therefore first carried out on the printing machine. This involves using the machine to reproduce a standard test strip, known as a step wedge, which carries a sequence of coloured patches or targets of the ink which is to be used for an ensuing print job, the ink patches being of graded density, varying from 0 to 100% in 5% increments. The density

of each of the ink patches on the resulting printed strip produced by the printing machine is then measured using an instrument known as a densitometer which is effectively a reflection photometer arranged to provide an optical measurement of the density of each patch on the printed strip. The deviations of the measured density values from the corresponding values of the standard dot gain profile stored on the machine are then determined and used to set the density values to be used for the print job in question. Often this calibration procedure has to be carried out several times before a satisfactory result is achieved.

It is an object of the present invention to provide an accurate and reliable method of calibrating a computer controlled printing machine and a calibration tool for use in performing the method of the invention.

Accordingly, in one aspect, the invention provides a method of calibration a computer controlled printing machine to produce printed copies of an original image to a pre-determined standard, comprising: using the printing machine to print a reproduction of a step wedge, having patches with densities concentrated in a central region of the density range, with the machine set to dot gain values corresponding to predetermined density values on a standard dot gain profile; measuring the density values of the patches of the printed reproduction of the step wedge; determining from the measured density values the position of the density exhibiting maximum measured dot gain; formulating a revised dot gain profile having the same shape as the standard dot gain profile but with a maximum dot gain which is equal to the maximum measured dot gain and which is located at the density having the maximum measured dot gain; determining revised dot gain values for the predetermined density values from

the revised dot gain profile; and setting the dot gain values in the printing machine in accordance with the revised dot gain values.

Preferably, the method comprises using a step wedge having ten patches at least some of which form a series of patches having density values covering the central region of the density range in steps.

In an embodiment of the invention, one of the patches has a density of 100% and the remaining nine patches have densities ranging from 42% to 58% in 2% steps.

Desirably, the step wedge is placed on a portion of the print job in an area outside the image area and the machine is used to produce a reproduction of the image plus step wedge.

Advantageously, the method of the present invention further comprises the steps of: using the printing machine to print a reproduction of a fine tuning step wedge, having patches with ranges of density values concentrated at the end regions of the density range, with the revised dot gain values determined from the measurements on the main step wedge; visually checking the patches printed by the machine for defects; and adjusting the dot gain values of the revised profile at an end region of the density range if a printed patch corresponding to that end region exhibits a defect.

Preferably, the method comprises using a fine tuning wedge having nine patches at least some of which have densities covering the two end regions of the density range in steps.

In one embodiment of the invention, one of the patches of the fine tuning wedge has a density of 50%, the patches of a first group of the remaining patches have densities ranging from 1% to 7% in 2% steps and the patches of a second group have densities ranging from 93 to 99% in 2% steps.

In another aspect, the invention provides a computer program adapted to perform the steps of the method according to the invention when loaded into a computer controlled printing machine.

In a further aspect, the invention provides a computer program in accordance with the invention embodied on a computer-readable medium.

According to yet another aspect, the invention provides a calibration tool for use in calibrating a computer controlled printing machine, which calibration tool comprises a step wedge provided with a series of colour patches having density values concentrated in a central region of the density range.

According to yet a further aspect, the invention provides a calibration tool for use in calibrating a computer controlled printing machine, which calibration tool comprises a step wedge provided with a series of colour patches having density values concentrated at the end regions of the density range.

In order that the invention may be more readily understood, an embodiment thereof will now be described in more detail, by way of example, with reference to the accompanying drawings, in which:

Figure 1 is a very simplified block diagram illustrating the components of a computer-controlled printing machine;

Figure 2 and 3 are graphs of dot gain versus density illustrating dot gain profiles measured for two different colours at different densities using a known calibration method;

Figure 4 is a graph showing dot gain profiles measured for different colours at different screen rulings, the results for each colour at different screen rulings being averaged to produce the illustrated average curves for each colour;

Figure 5 is a graph showing in solid line a dot gain profile obtained by taking an overall average of the dot gain profiles for different colours shown in Figure 4 and in broken line the standard dot gain profile supplied with the printing machine; and

Figure 6 is a schematic flow chart illustrating a calibration method embodying the present invention.

Referring firstly to Figure 1, a computer controlled printing machine 1 comprises an input scanner 2 for scanning an original image to be reproduced by the machine 1 and delivering a digital file representing the image as the values of the attributes, such as the colour and density, of a sequence of individual pixels in a raster of pixels into which the image is notionally analysed by the scanner 2. The digital file is passed to an image processing computer 3 of the machine 1 which, *inter alia*, serves to adjust the digital representation of the image in view of the transfer characteristics of the machine 1. The resulting processed digital image data is then used to control the production in a plate production stage 4 of a printing plate which is inked and applied to a substrate, such as paper, in a press 5 to produce a printed reproduction of the original image.

The computer 3 has print control software 3B and a memory 3A. An input/output device 6 with a display screen 6A and a keyboard 6B forms an interface with the computer to enable data to be input to and displayed by the computer 3.

The printing plate produced in the plate production stage 4 has an array of raised dots representing each pixel of the image to be reproduced. The proportion of the area of a pixel covered by dots on the plate determines the density of the corresponding area of colour on an image printed from the plate and varies from 0% to 100%.

When the printing plate is inked and applied to the substrate in the press 5, the printed dots exhibit an effect called dot gain, whereby the shore line of the printed dots of ink spreads and thus increases the ink-bearing area of the pixels. For any given ink, the dot gain varies with the density of the pixel to be printed in accordance with a dot gain profile which rises progressively, but non-linearly, with increasing density from zero up to a maximum value near the middle of the density range and then progressively decreases again in a non-linear manner to zero as the density increases to a maximum. The dot gain profile also depends upon the particular ink being printed. This dot gain affects the transfer function of the printing machine and thus has to be taken into account when processing the digital representation of the image in the image processing computer 3 of the machine 1. To this end, the memory 3A of the computer 3 stores standard dot gain calibration data in the form of a set of dot gain values each corresponding to a predetermined density value on a standard dot gain profile, which calibration data is intended to be applied to the digital image data from the scanner 2 to adjust the image data in the light of the anticipated dot gain profile in order to produce a printed image which is a

faithful reproduction of the original image. Such a standard dot gain profile is shown as curve 7 in Figure 5.

Unfortunately, the dot gain profile of new machines of the same model varies from machine to machine, and also varies with the age of the machine. Consequently, the standard dot gain calibration data alone is incapable of providing prints of the required standard. As a result, it is conventional to carry out an additional calibration procedure prior to printing in an attempt to adjust the calibration data to suit the actual dot gain profile of the particular machine 1. This calibration procedure involves printing an image of a standard step wedge having a sequence of colour patches of different standard densities, measuring the density of the resulting printed patches using a densitometer in the form of a reflection photometer, determining the difference between the measured density data and the standard density data of the step wedge and using this difference to adjust the dot gain calibration data in the image processing computer.

The known additional calibration procedure lacks consistency and accuracy and, as a result, the additional calibration procedure often has to be repeated several times using the newly adjusted calibration data each time before an acceptable result can be achieved.

Extensive research by the Applicant has revealed that one factor responsible for the lack of accuracy in the additional calibration procedure is the inherent inaccuracy of the densitometer, particularly as used to measure densities at the extreme ends of the density range corresponding to highlights and shadows. This instrument inaccuracy arises from the +/- 1% accuracy of the actual measurement and the approximation inherent in the equation used to convert density into dot area. Tests carried out using yellow ink of weight 1.03 and

black ink of 1.87 (representing light and heavy inks respectively) and the known additional calibration procedure gave the results depicted in Figures 2 and 3. These Figures show that, when plotted as a graph, each of the two sets of measured dot gain values formed an irregular profile 8 (Figure2) and 9 (Figure 3).

Another factor that affects the accuracy of the known additional calibration procedure has been shown to be the fact that the dot gain profile increases overall with the screen ruling value with the value of the density at which the maximum dot gain occurs also moving as the screen ruling value is changed. Thus tests carried out by the Applicant have shown that the maximum dot gain occurs at a density of 50% for a screen ruling value of 175 but occurs at closer to 60% for a screen ruling value of 250. The test results indicate that the main contributing factor to this change in the shape of the dot gain profile is the frequency of the dots, which has an effect on the overall shore line or perimeter of the dots within the measured area. Tests using films of the 175 and 250 screen samples enlarged times 4 to print on large format machines (at screen ruling values of approximately 43 and 62 respectively) were found to print with the same characteristics, the maximum dot gain for the 43 screen ruling value being at 50% density and the maximum dot gain for the 62 screen ruling value being closer to 60%.

Tests were also carried out to determine whether dot gain varies with the weight of the ink being used. By way of example, the test results using magenta ink of different weights are tabulated below for the dot at 50% density and are typical of the results obtained using inks of different colours and from different manufacturers.

Ink Weight	Dot Gain @ 50%	Difference	Effect
1.2	12%	start point	too light
1.3	14%	+2%	
1.4	14%	+0%	
1.5	14%	+0%	optimum
1.6	15%	+0%	
1.7	16%	+1%	
1.8	18%	+2%	too dark

From these tests it was found that increases in dot gain with increasing ink weight were substantially consistent within the printable band of ink weights regardless of the colour or manufacturer.

Further tests were carried out to investigate whether or not inks of different colour exhibit a dot gain profile of the same shape. Measurements were taken from the same test sheet printed using different ink weights on an SM74 press, the measuring instrument being a Gretag densitometer. The results for each colour were first averaged to obtain a set of four averaged individual colour profiles 10 as shown in Figure 4. The resulting individual colour profiles were then all averaged together to form a resultant average profile for all colours shown, after smoothing, as solid line 11 in Figure 5 which also shows, in broken line, the single standard dot gain profile 7 supplied by the manufacturer. These results suggest that all colours of ink print with basically the same shape of dot gain profile but with a maximum dot gain at a density value which does not coincide with the value indicated by the standard profile.

In order to overcome the inherent inaccuracy of the known calibration procedure as described above, a calibration method embodying the present

invention employs a pair of calibration step wedges for carrying out respective main calibration and fine tuning procedures. Exemplary main and fine tuning step wedges each comprise a series of ten colour patches of different density for each colour with each patch being in the form of a circle having a diameter of from 3.5 to 4mm. The patches of the main step wedge are concentrated in the middle of the density range, where the measurement accuracy of a densitometer is at its maximum, and the patches of the fine tuning step wedge are concentrated at the extremities of the density range. An example of suitable patch densities for each of the two step wedges is given below:

Main Step Wedge	Fine Tuning Step Wedge
100%	99%
42%	97%
44%	95%
46%	93%
48%	
50%	50%
52%	7%
54%	5%
56%	3%
58%	1%

The above density values for the step wedges are given merely by way of example and other values could also be used. For example, the main step wedge could have one patch with a density of 100% and the remaining nine patches with densities ranging from 30% to 70% in 5% steps.

Referring now to Figure 6, in carrying out a calibration method embodying the present invention, a first step S1 of a main calibration procedure is to place the

main step wedge in the gutter of the real print job carrying the original image to be reproduced. The gutter is a region between lines of cut made to separate the desired image from the printed job. The job is then printed using conventional ink weights and with the standard dot gain settings. In a second step S2, the dot gain values of the printed copy of the main step wedge are measured and the values entered into the image processing computer 3. The print control software 3A of the computer includes calibration software which is adapted in step S3 to determine from the measured values the position of the density exhibiting the maximum measured dot gain, in step S4 to formulate a revised dot gain profile having the same shape as the standard dot gain profile but with a maximum dot gain which is equal to the maximum measured dot gain and which is located at the density having the maximum measured dot gain, in step S5 to determine revised dot gain values for the predetermined density values from the revised dot gain profile and in step S6 to write the revised dot gain values to a RIP (Raster Image Processor) of the printing machine which then controls the production of a printing plate in accordance with the revised dot gain values in place of the dot gain values of the standard dot gain profile.

The dot gain settings obtained from the main calibration procedure may be refined by means of a fine tuning calibration in which: in step S10 the fine tuning step wedge is placed in the gutter of the print job and the job is printed with the main calibration settings. In step S11 the printed job is then visually inspected for broken dot on highlight and filling in on shadow. If defects are detected, changes can be manually entered into the computer 3 in step S12 via the calibration software to adjust the dot gain settings for either or both of the highlight region (density value of 1% at the lower end of the density range) and shadow region (density value of 99% at the upper end of the density range) in increments of 0.1% until the desired print standard is achieved. This change in

the extreme dot settings is reflected throughout the range but with decreasing effect towards the middle of the density range.

A calibration method embodying the invention is able to provide data correction for a number of printing applications and is able to be used with a wide range of equipment. The method enables consistent printing results to be obtained regardless of the age or manufacturer of the printing machine and can match the printed results of CTP to film. Moreover, the method enables higher screen rulings to be printed with ease. Since the method does not require test plates, being set up via a step wedge placed in the gutter of a real print job, it is user friendly and enables easier matching of proofs.

In the present specification "comprise" means "includes or consists of" and "comprising" means "including or consisting of".

The features disclosed in the foregoing description, or the following claims, or the accompanying drawings, expressed in their specific forms or in terms of a means for performing the disclosed function, or a method or process for attaining the disclosed result, as appropriate, may, separately, or in any combination of such features, be utilised for realising the invention in diverse forms thereof.

CLAIMS

1. A method of calibrating a computer-controlled printing machine to produce printed copies of an original image to a pre-determined standard, comprising: using the printing machine to print a reproduction of a step wedge, having patches with densities concentrated in a central region of the density range, with the machine set to dot gain values corresponding to pre-determined density values on a standard dot gain profile; formulating a revised dot gain profile having the same shape as the standard dot gain profile but with a maximum dot gain which is equal to the maximum measured dot gain and which is located at the density having the maximum measured dot gain; determining revised dot gain values for the predetermined density values from the revised dot gain profile; and setting the dot gain values in the printing machine in accordance with the revised dot gain values.

2. A method according to Claim 1, comprising using a step wedge having ten patches at least some of which form a series of patches having density values covering the central region of the density range in steps.

3. A method according to Claim 2 comprising using a step wedge in which one of the patches has a density of 100% and the remaining nine patches have densities ranging from 42% to 58% in 2% steps.

4. A method according to Claim 2 comprising using a step wedge in which one of the patches has a density of 100% and the remaining nine patches have densities ranging from 30% to 70% in 5% steps.

5. A method according to any preceding Claim, comprising placing the step wedge on a portion of the print job in an area outside the image area and using the machine to produce a reproduction of the image plus step wedge.

6. A method according to any preceding Claim, further comprising the steps of: using the printing machine to print a reproduction of a fine tuning step wedge, having patches with ranges of density values concentrated at the end regions of the density range, with the revised dot gain values determined from the measurements on the main step wedge; visually checking the patches printed by the machine for defects; and adjusting the dot gain values of the revised dot gain profile at an end region of the density range if a printed patch corresponding to that end region exhibits a defect.

7. A method according to Claim 6, comprising using a fine tuning wedge having nine patches at least some of which have densities covering the two end regions of the density range in steps.

8. A method according to Claim 7, comprising using a fine tuning wedge in which one of the patches has a density of 50%, the patches of a first group of the remaining patches have densities ranging from 1% to 7% in 2% steps and the patches of a second group have densities ranging from 93% to 99% in 2% steps.

9. A computer program adapted to perform the steps of the method according to any preceding Claim when loaded into a computer-controlled printing machine.

10. A computer program according to claim 9 embodied on a computer-readable medium.

11. A calibration tool for use in calibrating a computer-controlled printing machine, which calibration tool comprises a step wedge provided with a series of colour patches having density values concentrated in a central region of the density range.

12. A calibration tool according to Claim 11wherein the step wedge includes one patch having a density of 100% and nine other patches having densities ranging from 42% to 58% in 2% steps.

13. A calibration tool according to Claim 12 wherein the step wedge includes one patch having a density of 100% and nine other patches having densities ranging from 30% to 70% in 5% steps.

14. A calibration tool for use in calibrating a computer-controlled printing machine, which calibration tool comprises a step wedge provided with a series of colour patches having density values concentrated at the extremes of the density range.

15. A calibration tool according to Claim 14 wherein the step wedge has one patch with a density of 50%, a first group of other patches having densities ranging from 1% to 7% in 2% steps and a second group of other patches having densities ranging from 93% to 99% in 2% steps.

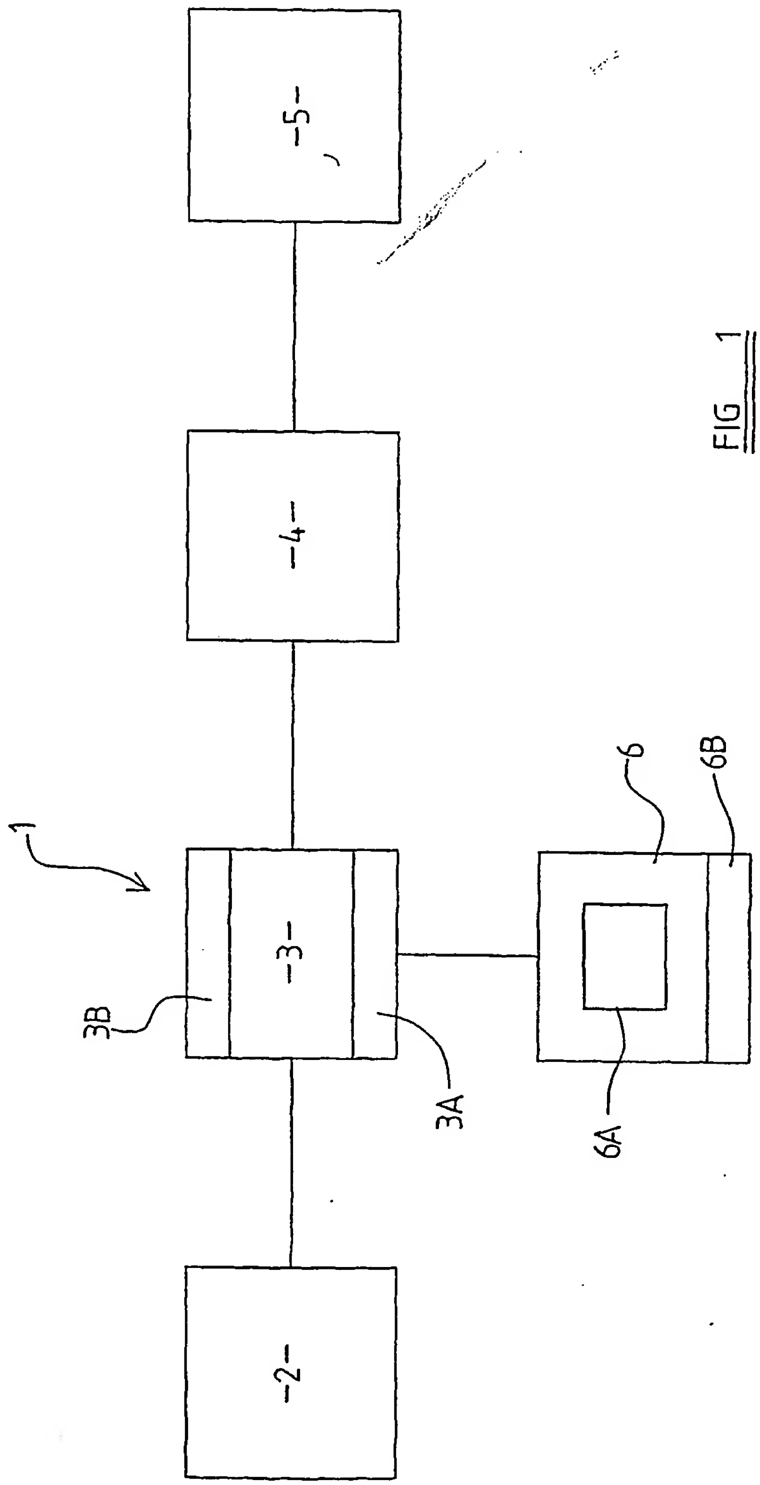

FIG 1

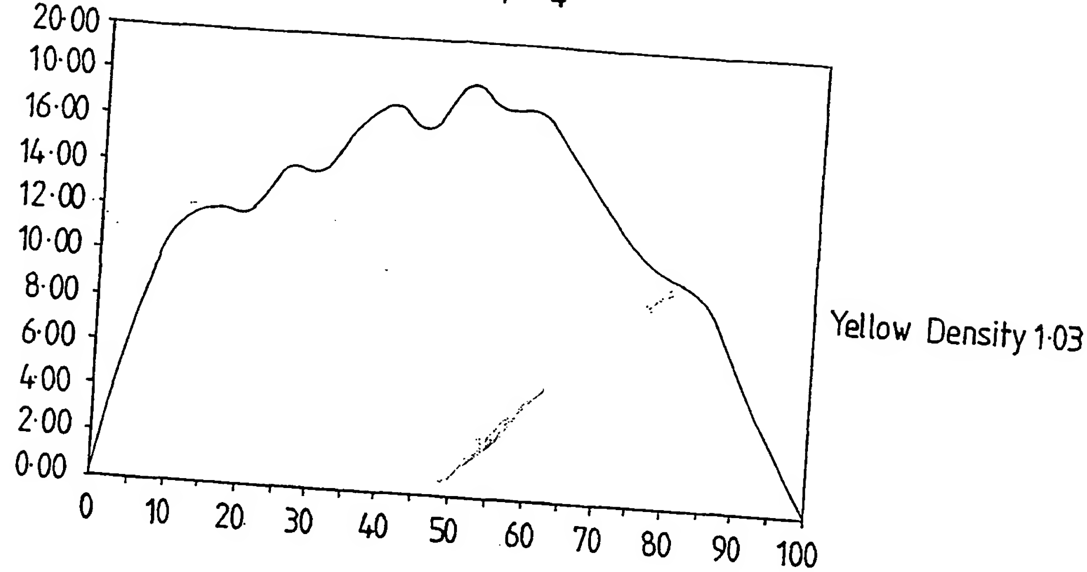

FIG 2

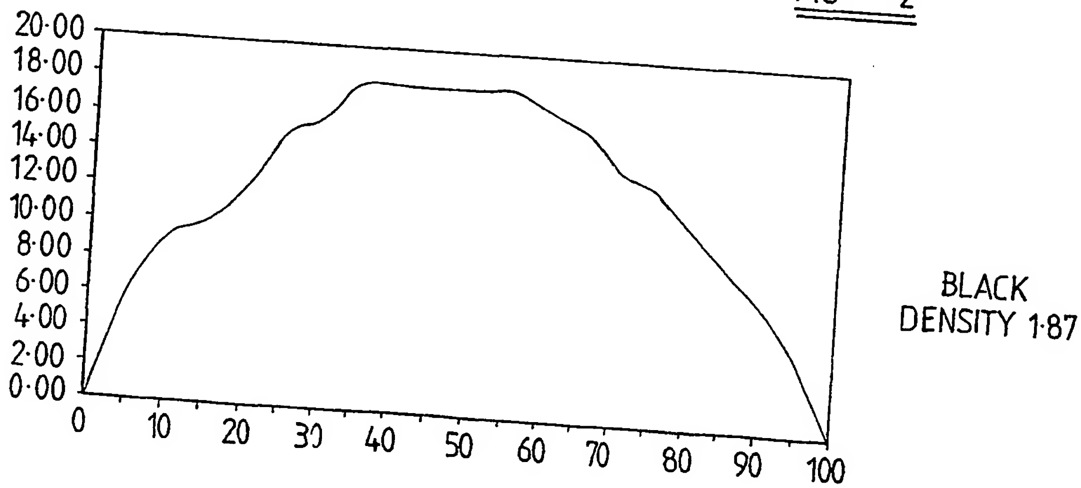

FIG 3

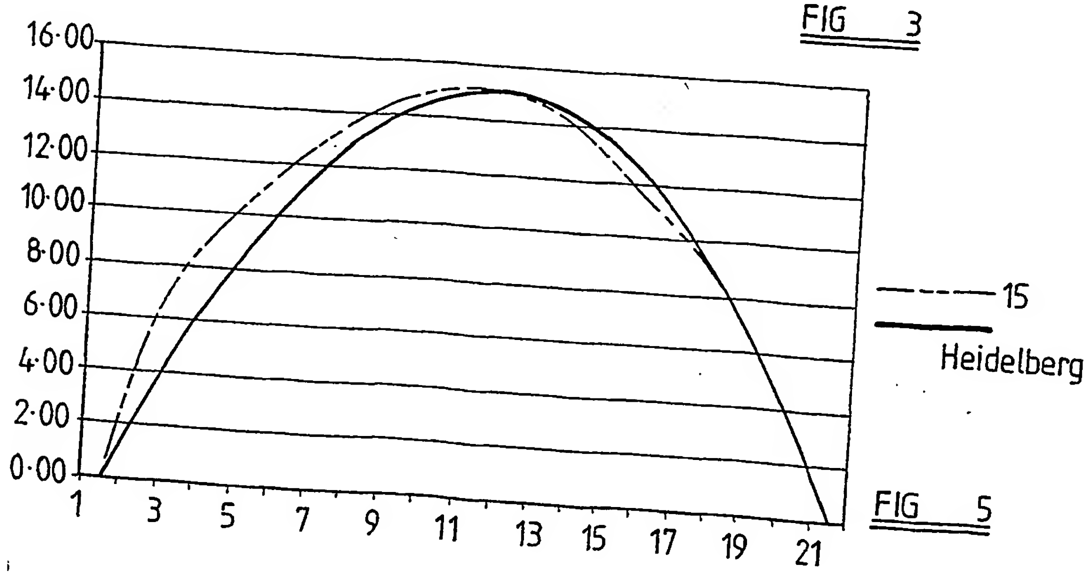

FIG 5

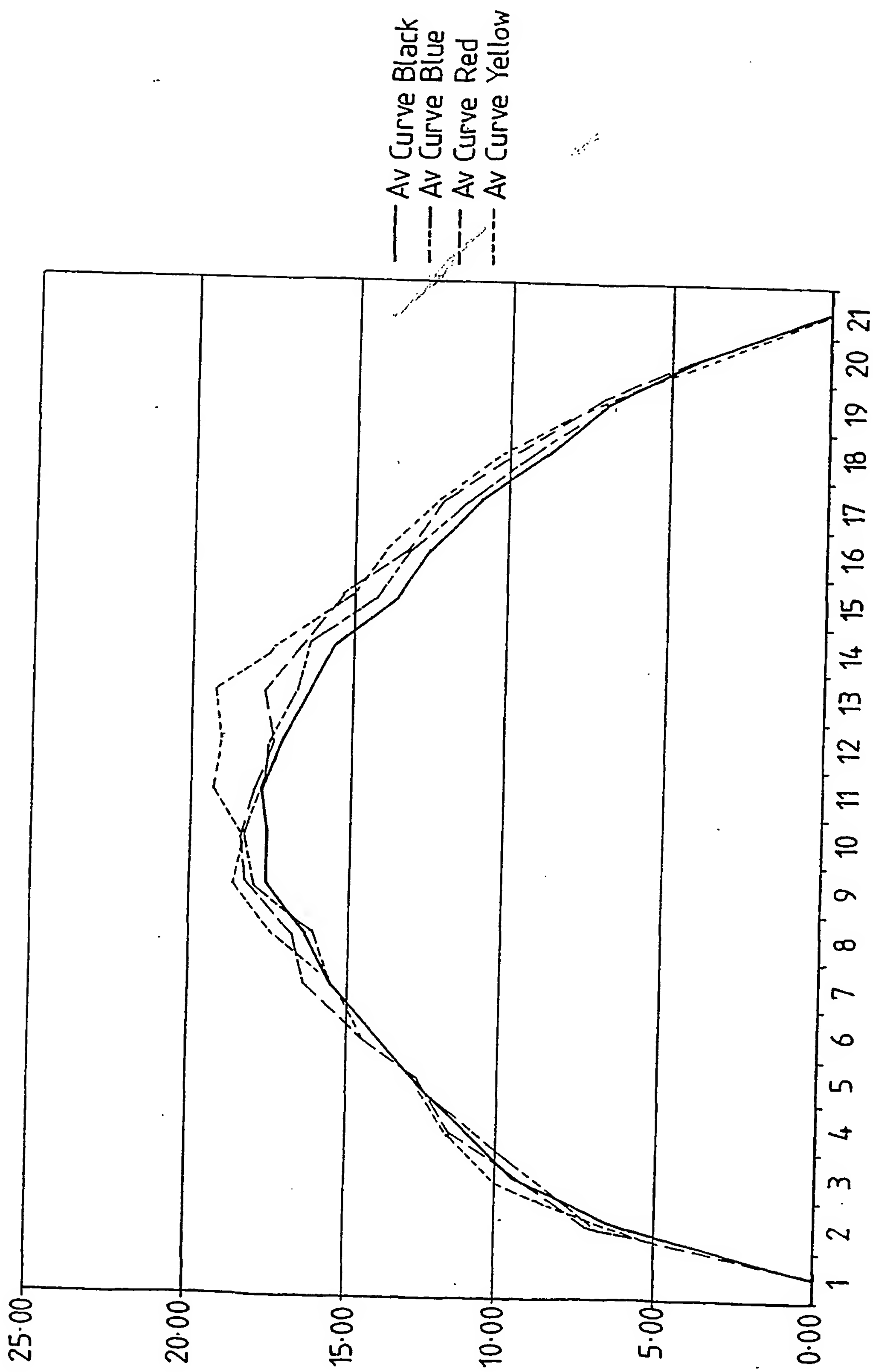
Av Curve Black
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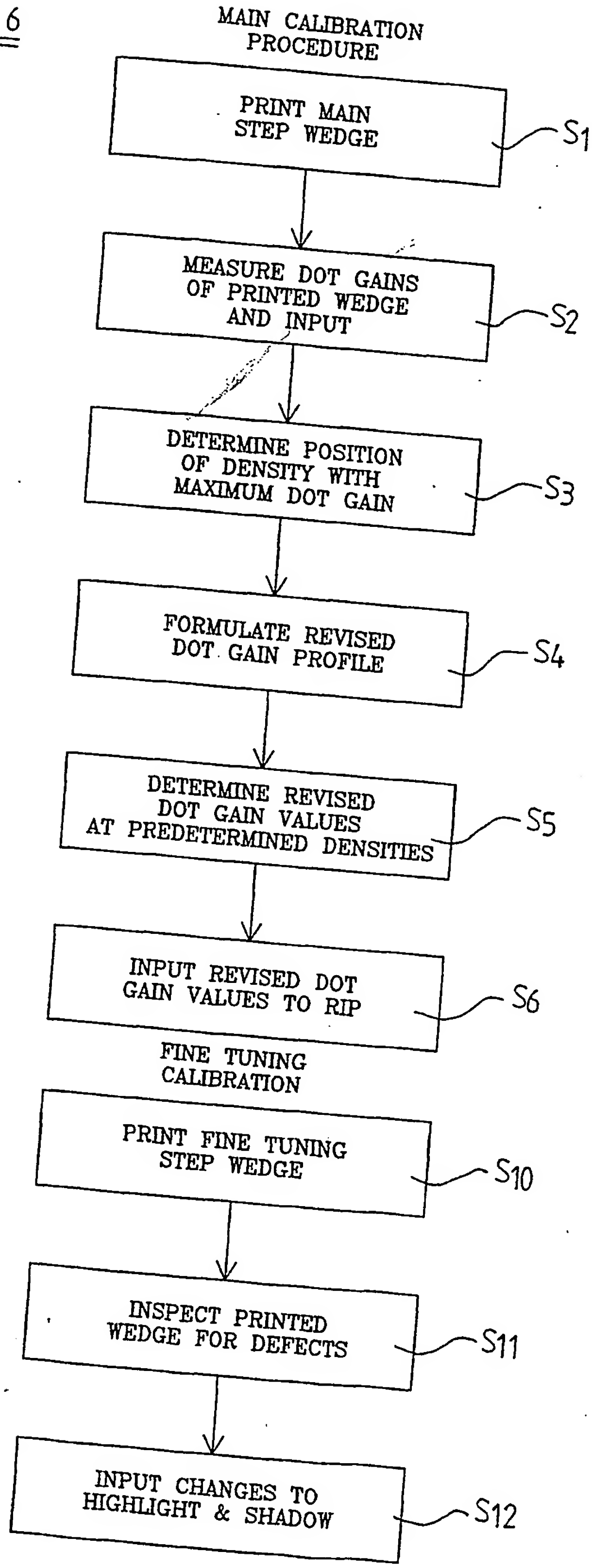
FIG 4

FIG 6


MAIN CALIBRATION PROCEDURE
PRINT MAIN STEP WEDGE
S1
MEASURE DOT GAINS OF PRINTED WEDGE AND INPUT
S2
DETERMINE POSITION OF DENSITY WITH MAXIMUM DOT GAIN
S3
FORMULATE REVISED DOT GAIN PROFILE
S4
DETERMINE REVISED DOT GAIN VALUES AT PREDETERMINED DENSITIES
S5
INPUT REVISED DOT GAIN VALUES TO RIP
S6
FINE TUNING CALIBRATION
PRINT FINE TUNING STEP WEDGE
S10
INSPECT PRINTED WEDGE FOR DEFECTS
S11
INPUT CHANGES TO HIGHLIGHT & SHADOW
S12

INTERNATIONAL SEARCH REPORT

Int nal Application No
PCT/GB 01/02248

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 H04N1/407

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 H04N B41F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, WPI Data, INSPEC, COMPENDEX

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 5 293 539 A (J. P. SPENCE) 8 March 1994 (1994-03-08) column 7, line 21 - line 35 column 10, line 39 -column 11, line 28	1
A	WO 99 26407 A (MINNESOTA MINING AND MANUFACTURING COMPANY) 27 May 1999 (1999-05-27) page 2, line 8 -page 3, line 17 page 10, line 29 -page 11, line 23	1
X	EP 0 864 422 A (BAYER CORPORATION) 16 September 1998 (1998-09-16)	11-15
A	column 2, line 1 - line 38 column 14, line 44 -column 21, line 13	1-10

☐ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

° Special categories of cited documents :

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Date of the actual completion of the international search	Date of mailing of the international search report
14 September 2001	21/09/2001

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	De Roeck, A

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No
PCT/GB 01/02248

Patent document cited in search report		Publication date	Patent family member(s)		Publication date
US 5293539	A	08-03-1994	DE	69225553 D1	25-06-1998
			DE	69225553 T2	07-01-1999
			EP	0538901 A2	28-04-1993
			JP	6006602 A	14-01-1994
			US	5255085 A	19-10-1993
WO 9926407	A	27-05-1999	US	6191867 B1	20-02-2001
			EP	1033030 A1	06-09-2000
			WO	9926407 A1	27-05-1999
EP 864422	A	16-09-1998	US	6219154 B1	17-04-2001
			EP	0864422 A2	16-09-1998
			JP	11005329 A	12-01-1999